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VII

CLIMATIC ZONES OF MARTINEZ EOCENE TIME*

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Strata of Martinez age occur in California in two distinct basins, the San Francisco and Los Angeles basins. Of these, the San Francisco basin is roughly outlined by the occurrence at Lower Lake, Lake Co., Cal., at Martinez, on the San Francisco bay shore, Mt. Diablo region, and San Pedro Point, San Mateo Co., Cal. The eastern extension of this line is influenced by the character of the deposits in the vicinity of the Diablo region as they were in large part laid down in waters of moderate depth, whereas those of Lower Lake are evidently littoral in the broad sense. The bases for the strand line of the Los Angeles basin were determined from a study of Martinez strata in the Simi hills, near Santa Susana, at Rock Creek in the southern edge of the Mohave desert and in the Santa Ana mountains. Although the Martinez fauna obtained from both these basins has an essential unity, yet there are certain significant differences which will be described later. The Martinez sea, judging from absence of sediments of Lower Eocene age, did not cover the great area between Mount Diablo and the Tehachapi mountains. See Fig. 1.

It is evident from the mapping that in the San Francisco basin, the Tejon strand line is in general more easterly while in the Los Angeles basin, this line is the more westerly.

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The principal evidences of climate during Tejon time are yielded by a study of plants and invertebrate marine forms. Of these, the plants give very strong evidence of a mild climate far to the north. Palms have been reported from the carbonaceous deposits of Washington and from the Peacock mine in



Fig. 1. Map of California showing probable extent of the Tejon and Martinez Seas. The line which in general is the more easterly marks the maximum inland extension of the Tejon Sea and the other line indicates the probable easterly limit of the Martinez Sea.

1, Tejon of Round Valley, Mendocino County; 2, Tejon near Oroville; 3, Tejon of Marysville Buttes; 4, Tejon at mouth of Merced River Cañon; 5, Tejon of the Tehachapi Mountains; 6, Martinez of Rock Creek; 7, Tejon of San Diego County; 8, Tejon and Martinez at Clear Lake; 9, Martinez north of Suisun; 10, Martinez and Tejon at Benicia; 11, Type locality of Martinez; 12, Martinez and Tejon north of Mount Diablo; 13, Martinez and Tejon south of Mount Diablo; 14, Martinez of San Pedro Point, San Mateo County; 15, Tejon at New Idria; 16, Tejon at Coalinga District; 17, Tejon of the Santa Clara Valley; 18, Martinez of Calabassas Quadrangle; 19, Tejon and Martinez of the Santa Ana Mountains; 20, Tejon near San Diego.

the Mt. Diablo region. It has recently been shown that the Tertiary gravels of the Sierra Nevada are of Tejon Eocene age.¹ These gravels and interbedded clays have yielded a considerable flora. Knowlton² states that *Laurus* (4 species), *Persea* (3 species), *Oredaphne* (2 species), *Cinnamomum* (2 species), *Artocarpus* (2 species), *Zizyphus* (2 species), *Ficus* (6 species), and *Sabalites* (1 species), are tropical or semi-tropical genera which are abundant in these strata. He compares this flora to that of Florida today. In addition to these are several species such as liquidambar and magnolia, characteristic genera of the warm temperate climate.

Voluta lawsoni, *Macrocallista conradiana*, *Oliverata californica*, *Surcula crenatospira* and *Cardium dalli* occasionally retain the high coloring characteristic of many tropical genera. The fauna of the Tejon contains many genera characteristic of the tropics of the present day.

Among these are *Voluta*, *Siphonalia*, *Turris*, *Surcula*, *Terebra*, *Cancellaria*, *Drillia*, *Architectonica*, and *Conus* in abundance. In addition the colonial corals, *Dendrophyllia tejonensis* and *Thamnasteria sinuata* have been recently described from the type Tejon and the Tejon of the Mt. Diablo region. The ornamentation of the Tejon species is in general much greater than that of the Martinez. This is explained in part by a milder climate during Tejon time and by the fact that the Martinez fauna is a simple Tertiary fauna as yet undeveloped.

As was stated above there is an essential faunal unity in the Los Angeles and San Francisco basins, but there are certain significant differences which were particularly impressive while collecting in the field. Laboratory studies confirm this. At certain horizons in the Sini hills a good percentage of the rocks consisted of massed *Turritellas*, at other horizons *Siphonalia mucronata*, and *Amauropsis martinezensis* were particularly abundant. One of the striking features was the occurrence in great abundance of one of the *Volutidæ*, a form described by Gabb under the name of *Turbinella crassateta*. This species is an exceedingly rare form in the San Francisco

¹ Dickerson, R. E., Stratigraphy and Fauna of the Tejon Eocene of California, Univ. Calif. Publ. Bull. Dept. Geol., vol. 9, p. 398, 1916.

² Knowlton, F. H., in Topographic Revolution on the Pacific Coast, Fourteenth Annual Report, U. S. Geological Survey, pt. 2, p. 421, 1894.

basin and the abundance of this Volute, a characteristic tropical form, in the Los Angeles basin at the Simi hills localities is significant. The great variety of *Turritellas* and their abundance is another feature of the Martinez fauna of the Simi hills. *Turritella martinez*, *Turritella macreadyi*, *Turritella pachecoensis*, *Turritella*, new species, *a*, *Turritella*, new species, *b*, and *Turritella*, new species, *c*, are *Turritellas* whose ornamentation suggests life in tropical or semi-tropical waters. *Pseudoliva howardi* described from the Martinez of the Rock Creek region also occurs in the Simi hills. Apparently this highly specialized form is limited to the Los Angeles basin. The genus *Cerithium* is now represented by two species in the Los Angeles basin, *Cerithium butterworthi* and *Cerithium*, new species. *Ovula*, new species, was collected in the Simi hills in two or three localities. The much greater variety and higher ornamentation of the *Pleurotomidæ* in the fauna of the Simi hills is in decided contrast with the simpler types of this family in the San Francisco basin. This evidence indicates then that the Martinez of the Los Angeles basin was deposited in sub-tropical seas, while that of the San Francisco basin was deposited in waters which more nearly correspond to temperate conditions of today.

Such studies of climatic conditions enable the student of the distribution of life to complete, in part, a picture of the past. That climatic changes in the past were some of the principal causes of faunal changes is more and more being realized as the invertebrate faunas of the Pacific Coast and their relationships are becoming known. The closing or the opening of certain portals or gateways such as occur in the Panama and Bering regions have not only influenced the distribution of land animals but marine invertebrates as well. That the Bering portal was closed during Martinez time is strongly suggested by the occurrence of a Martinez invertebrate fauna in Japan. Incidental to the closing of this gateway, a shifting of oceanic currents resulted, and this in turn was reflected by the fauna of the lower Eocene. In conclusion: well marked climatic zones were present during lower Eocene time in contrast with the genial climate of the Tejon whose faunas of the far north still bear evidences of a tropical origin.